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Diabetes in Brazil: The Association between Extreme Heat and Hospitalization

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Exposure to excessive heat has been associated with an increased risk of medical problems associated with chronic diseases such as heart disease, respiratory diseases, and kidney disease.[1,2] Previous studies have also linked extreme heat with diabetes-related mortality,[3] although other work has found conflicting results.[4,5] Individuals with type 1 or type 2 diabetes often have difficulty sweating sufficiently to reduce their core body temperature, making it harder to keep cool in a hot environment.[6] A study recently published in *Environmental Health Perspectives* reported an association between hot outdoor temperatures and hospitalizations of patients with diabetes in Brazil.[7]

Investigators led by senior research fellow Shanshan Li and professor Yuming Guo, both of Monash University in Melbourne, Australia, collected data on hospitalizations and weather conditions from 1,814 Brazilian cities from 2000 through 2015. Using a time-stratified case-crossover approach, the researchers analyzed data just for each city's hot season—defined as the four hottest contiguous months in that specific location.

Over the study period, there were 553,351 diabetes-related hospitalizations. Every 5°C (9°F) increase in daily average temperature was associated with an estimated 6% increased risk of hospitalization on the same day and over the following three days. The association was greatest in adults over 80 years of age. In this group, an increase in daily average temperature of 5°C (9°F) was associated with an 18% increased risk of hospitalization.

The finding in older diabetes patients is not surprising, says Guo. "The elderly in general are much more vulnerable to heat. They cannot adjust well to extremely high temperatures. They are more likely to have underlying cardiovascular and respiratory disease," he says. Previous studies have shown that dehydration is common in the elderly, with some research suggesting that up to one-third of older adults may be routinely dehydrated.[8]

Future studies might consider underlying cardiovascular or kidney diseases, which could explain or modify heat effects. Data on air pollution exposures also would be helpful.

Previous studies found that outdoor air pollution, especially fine particulate matter, may contribute to an increased risk of developing diabetes, although potential effects on diabetes morbidity or hospitalizations remain unclear.[9,10] "It's an area where more research is needed," says Kristie Ebi, an epidemiologist at

Diabetes is relatively common in Brazil. Some surveys suggest regional prevalences of 12.1–13.5%,[11] compared with an overall prevalence in high-income countries estimated at 6.6%.[12] Brazil is also one of the countries in the world most affected by climate change, as reflected by the larger-than-average increases in surface temperature recorded there over the past century.[13] Image: © iStockphoto/MesquitaFMS.

the University of Washington, who was not involved in the current study. She adds, "This study serves as further confirmation that there are a range of groups, especially older adults with diabetes, that are highly vulnerable to higher temperatures."

Public health officials can use such information, says Guo, to prioritize efforts for preventing heat-related health effects in their communities. He believes the Brazil findings may be generalizable to other countries with high rates of diabetes, such as China and India, and could be used to guide future research efforts in those countries. "Future studies also should project changes in the disease burden with climate change so that steps can be taken to mitigate human health risks," he says.

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References

1. Anderson GB, Bell ML. 2011. Heat waves in the United States: mortality risk during heat waves and effect modification by heat wave characteristics in 43 U.S. communities. Environ Health Perspect 119(2):210–218, PMID: 21084239, https://doi.org/10.1289/ehp.1002313.
2. Green H, Bailey J, Schwarz L, Vanos J, Ebi K, Benmarhnia T. 2019. Impact of heat on mortality and morbidiy in low and middle income countries: a review of the epidemiological evidence and considerations for future research. Environ Res 171:80–91, PMID: 30660921, https://doi.org/10.1016/j.envres.2019.01.010.
3. Yang J, Yin P, Zhou M, Ou C-Q, Li M, Liu Y, et al. 2016. The effect of ambient temperature on diabetes mortality in China: a multi-city time series study. Sci Total Environ 543(Pt A):75–82, PMID: 26580729, https://doi.org/10.1016/j.scitotenv.2015.11.014.
4. Semenza JC, McCullough JE, Flanders WD, McGeehin MA, Lumpkin JR. 1999. Excess hospital admissions during the July 1995 heat wave in Chicago. Am J Prev Med 16(4):269–277, PMID: 10493281, https://doi.org/10.1016/s0749-3797(99)00025-2.
5. Knowlton K, Rotkin-Ellman M, King G, Margolis HG, Smith D, Solomon G, et al. 2009. The 2006 California heat wave: impacts on hospitalizations and emergency department visits. Environ Health Perspect 117(1):61–67, PMID: 19165388, https://doi.org/10.1289/ehp.11594.
6. Fealey RD. 2018. Thermoregulation in neuropathies. Handb Clin Neurol 157:777–787, PMID: 30459040, https://doi.org/10.1016/B978-0-444-64074-1.00048-3.
7. Xu R, Zhao Q, Coelho MSZS, Saldiva PHN, Zoungas S, Huxley RR, et al. 2019. Association between heat exposure and hospitalization for diabetes in Brazil during 2000–2015: a nationwide case-crossover study. Environ Health Perspect 127(11):117005, PMID: 31746643, https://doi.org/10.1289/EHP5688.
8. Miller HJ. 2015. Dehydration in the older adult. J Gerontol Nurs 41(9):8–13, PMID: 26375144, https://doi.org/10.3928/00989134-20150814-02.
9. Bowe B, Xie Y, Li T, Yan Y, Xian H, Al-Aly Z, et al. 2018. The 2016 global and national burden of diabetes mellitus attributable to $PM_{2.5}$ air pollution. Lancet Planet Health 2(7):e301–e312, PMID: 30074893, https://doi.org/10.1016/S2542-5196(18)30140-2.
10. Yang B-Y, Qian ZM, Li S, Chen G, Bloom MS, Elliott M, et al. 2018. Ambient air pollution in relation to diabetes and glucose-homeostasis markers in China: a cross-sectional study with findings from the 33 Communities Chinese Health Study. Lancet Planet Health 2(2):e64–e73, PMID: 29615239, https://doi.org/10.1016/S2542-5196(18)30001-9.
11. Bosi PL, Carvalho AM, Contrera D, Casale G, Pereira MA, Gronner MF, et al. 2009. Prevalence of diabetes and impaired glucose tolerance in the urban population of 30 to 79 years of the city of São Carlos, São Paulo [in Portuguese]. Arq Bras Endocrinol Metab 53(6):726–732, PMID: 19893915, https://doi.org/10.1590/S0004-27302009000600006.
12. Dagenais GR, Gerstein HC, Zhang X, McQueen M, Lear S, Lopez-Jaramillo P, et al. 2016. Variations in diabetes prevalence in low-, middle-, and high-income countries: results from the Prospective Urban and Rural Epidemiology study. Diabetes Care 39(5):780–787, PMID: 26965719, https://doi.org/10.2337/dc15-2338.
13. IPCC (International Panel on Climate Change). 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, et al., eds. New York, NY: Cambridge University Press.